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JOANNA COLE & BRUCE DEGEN

The Magic School Bus

and the Climate Challenge

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Ms. Frizzle's students are putting on a play about global warming, and they need some cold, hard facts. The Friz knows just where to find them! A hop on the Magic School Bus takes the kids on a whirlwind tour. From the Arctic to the equator, they see telltale signs of climate change. But to get the really big picture, the class has to get really small—so they can see exactly what is in the air and why it is making the world warmer. What they find gives them a real cause for concern! Luckily, the Friz has some hands-on advice.

With their knack for making science accessible, Joanna Cole and Bruce Degen give this hot topic a refreshing, kid-friendly spin that will inspire all to do their part.

Ms. Frizzle and her class are up for the climate challenge. Are you?

Jacket art © 2010 by Bruce Degen

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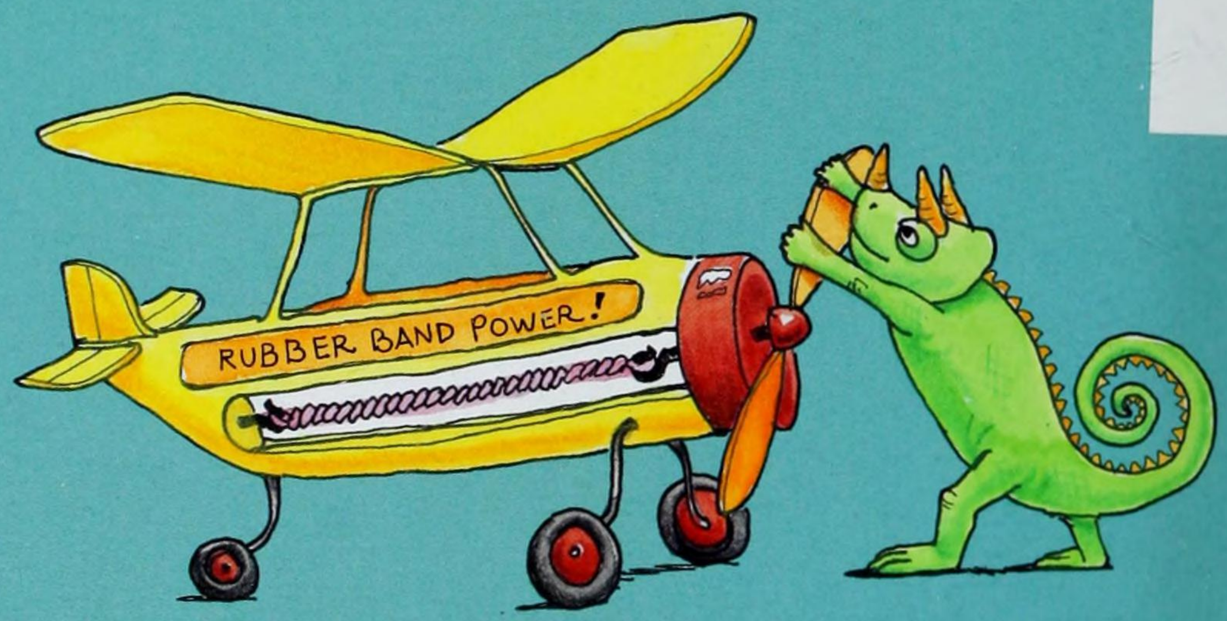

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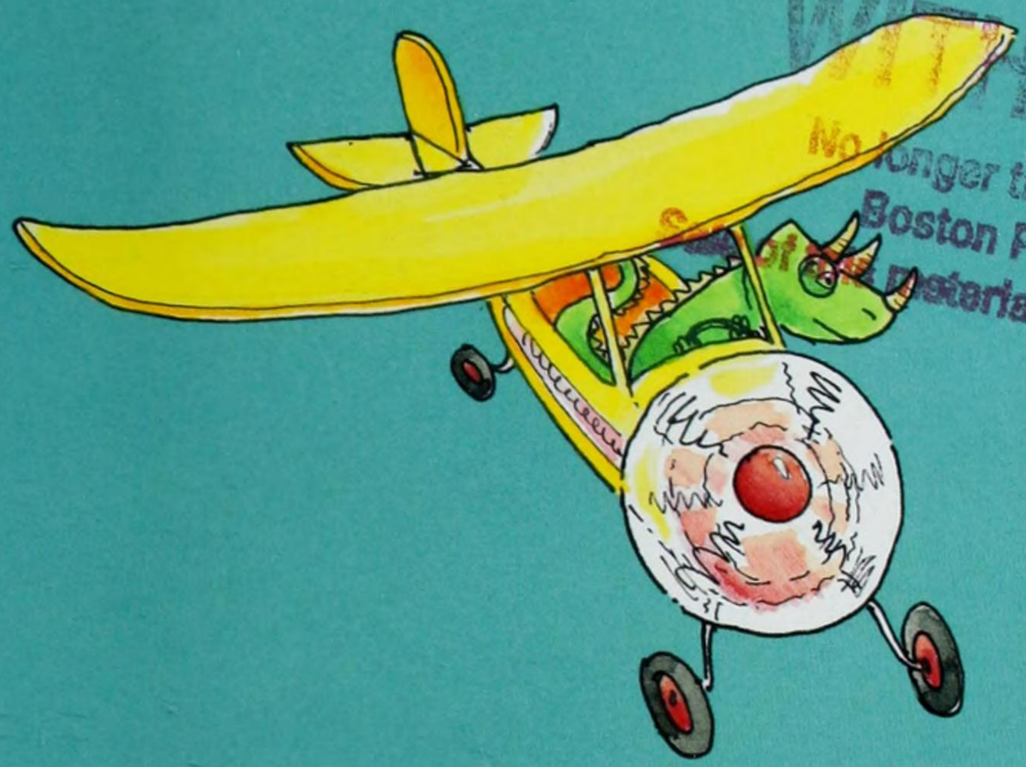

In memory of Craig Walker,
whose brilliant vision for making science exciting
and funny inspired the Magic School Bus series—
and both of us.
He was much loved, and is much missed.
—J.C. and B.D.

The Magic School Bus

and the Climate Challenge

Scenery for the Class Play...
WHITE

The Magic School Bus

and the Climate Challenge

By Joanna Cole
Illustrated by Bruce Degen

Scholastic Press / New York

Many have helped in the making of this book. In particular, our sincere thanks go to Dr. Bill Chameides, Dean and Nicholas Professor of the Environment, Duke University, for his enthusiastic and informed review.

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The text type was set in 15-point Bookman Light.
The illustrator used pen and ink, watercolor, color pencil, and gouache for the paintings in this book.
The text of this book prints on 100% recovered fiber of which 50% is post-consumer waste.

To all our friends in Korea.
We will never forget your warm and enthusiastic
welcome to The Magic School Bus, and to us.
— J.C. and B.D.

Have you heard about our teacher, Ms. Frizzle? Almost every day, something weird happens in her class.

For example, take the day we started to study global warming. We were going to put on a play about Earth and all the changes that are happening.
The Friz had brought a book from home, and we were using the pictures to help us paint the scenery.

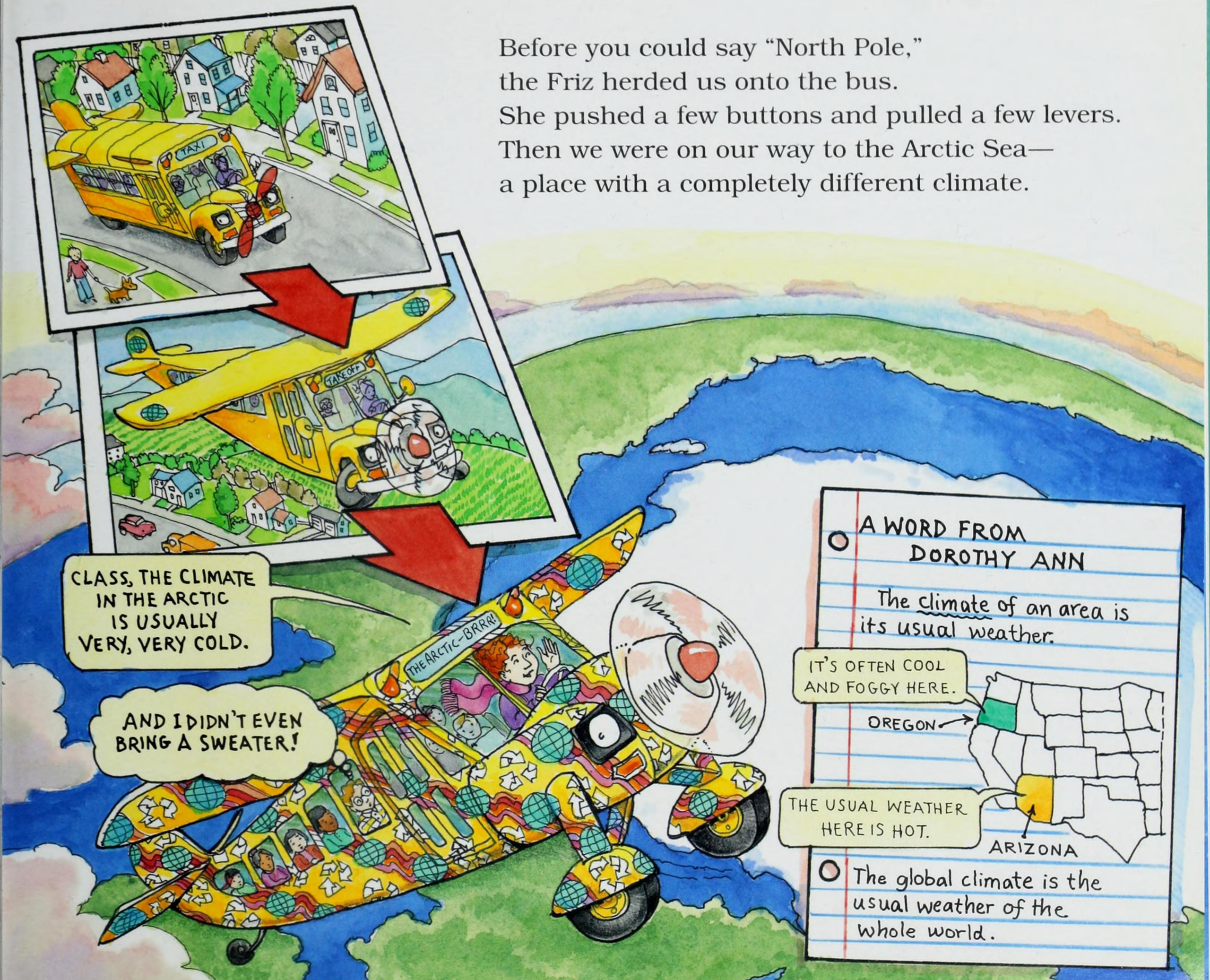
"Ms. Frizzle's book is kind of old," said Tim.
"It came out before things really started heating up."
"I'll go online to get new pictures," said Wanda.
She headed for a computer, but Ms. Frizzle was already out the door. "Come on, class," she called.
"Bring my book, please."

WHAT IS GLOBAL WARMING?
by Carlos
Global warming is a rise in the average temperature of the land and water on Earth. Today, the average temperature is more than 1 degree F warmer than it was 100 years ago.

One degree doesn't sound like much, but one small degree has caused big changes already— ice melting, seas rising, and more freak weather!

WELL, I'VE HEARD HER NAME IS VALERIE....
BUT I CAN'T BELIEVE SHE WAS EVER NINE!
LET'S GO!
OUR WONDERFUL WORLD
This book belongs to Valerie Frizzle age 9.

Before you could say "North Pole,"
the Friz herded us onto the bus.
She pushed a few buttons and pulled a few levers.
Then we were on our way to the Arctic Sea—
a place with a completely different climate.


TAXI
TAKEOFF
THE ARCTIC-BRRR!
CLASS, THE CLIMATE IN THE ARCTIC IS USUALLY VERY, VERY COLD.
AND I DIDN'T EVEN BRING A SWEATER!
A WORD FROM DOROTHY ANN
The climate of an area is its usual weather.
IT'S OFTEN COOL AND FOGGY HERE.
OREGON
THE USUAL WEATHER HERE IS HOT.
ARIZONA
The global climate is the usual weather of the whole world.

When we got there, Dorothy Ann opened
Ms. Frizzle's old book.
The pictures showed ice everywhere.
There was still plenty of ice in the Arctic,
but a lot had melted, and more
was melting all the time.

MELTDOWN
by Shirley

Melting is happening at the Arctic, Greenland, and the Antarctic.

It's also happening on mountaintops, like the ones in Glacier National Park.

ARCTIC
GLACIER NATIONAL PARK
GREENLAND
NORTH AMERICA
ATLANTIC OCEAN
PACIFIC OCEAN
ANTARCTIC

THE ARCTIC...

ICE EVERYWHERE!

BY THE TIME WE GROW UP...

...IT MAY BE CALLED GLACIER-LESS NATIONAL PARK.

BOULDER GLACIER, Glacier National Park

1932

TODAY

HOW IT LOOKED **THEN**

HOW IT LOOKS NOW

IN THE ARCTIC, AN AREA HAS MELTED THAT'S THE SIZE OF TEXAS AND CALIFORNIA COMBINED!

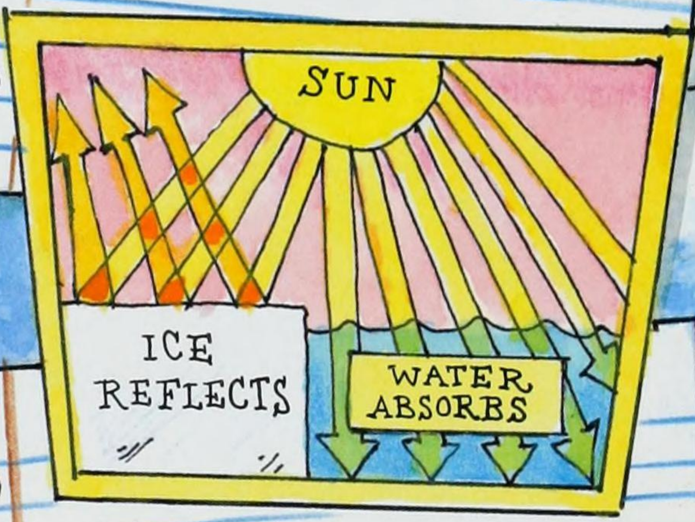
CALIFORNIA

TEXAS

MELTING CAUSES MORE MELTING
by Tim

Ice is white. White reflects most of the sunlight that hits it. So the sun can't heat up the ice.

Water is not white. It absorbs most of the sunlight that hits it. So the water gets warmer.



This starts a dangerous loop:

- The warm water melts more ice.
- That means there is more water.
- This water takes in more sunlight.
- So the water gets warmer and melts even more ice.

And so on, and so on, until all the ice is gone.

Ms. Frizzle steered the bus-plane
all over the earth.
We saw changes everywhere.

1. Global warming is melting permafrost, soil that is usually frozen.
THERE GOES THE HOUSE!
I'VE HAD IT UP TO HERE WITH ALL THIS MUD!
2. It makes some places too dry.
THIS USED TO BE OUR FARM.
NOW IT'S A DESERT.
3. It raises the sea level.
WE WANT TO STAY ON OUR ISLAND, BUT THE WATER IS RISING....
4. It changes the ocean chemistry and harms coral reefs and other sea life.
THIS IS TERRIBLE!

5. Warming causes stronger hurricanes and tornadoes...

...and more forest fires...

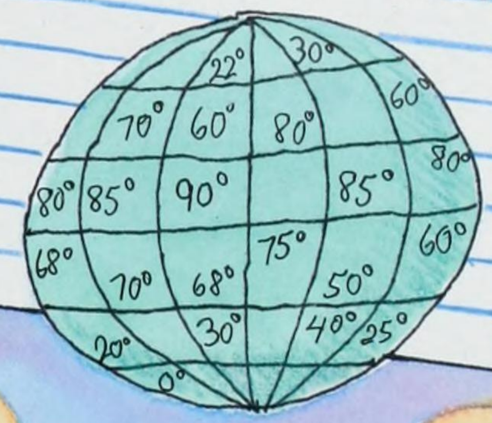
...and bigger blizzards.

GLOBAL WARMING PUTS MORE WATER IN THE AIR IN SOME PLACES. THAT MEANS MORE RAIN, AND, WHEN IT GETS COLD, MORE SNOW!

WHY IS THERE STILL COLD WEATHER?

by Keesha

Global warming means that the average temperature of the whole earth is rising. Different places still have different weather, but, in most places, there are more hot days and fewer cold days than before.



6. It causes animals and plants to die or to move.

IT'S TOO HOT HERE.

LET'S GO NORTH.

YELLOW-BELLIED MARMOTS

FIRE ANTS

7. Strange weather hurts food crops.

ICE ON AVOCADOS

THAT WHOLE CROP MIGHT BE LOST!

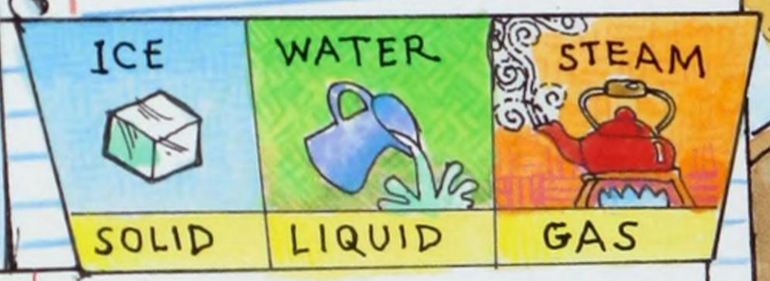
NO AVOCADOS? HOLY GUACAMOLE!

THE ATMOSPHERE ~
IT'S A GAS
by Phoebe

The earth is surrounded by layers of gases. All this gas is called the atmosphere.

WHAT ARE GASES?
by Arnold

Gases float and fill up any space they occupy.
A gas is thinner and lighter than a solid or liquid.



GASES IN THE ATMOSPHERE
by Molly

Most of the atmosphere is made up of these two gases:

OXYGEN (O_2)

NITROGEN (N_2)

"Aren't you children wondering why the earth is getting warmer and warmer?" asked Ms. Frizzle. Actually, we were wondering why she was steering the bus-plane higher and higher.

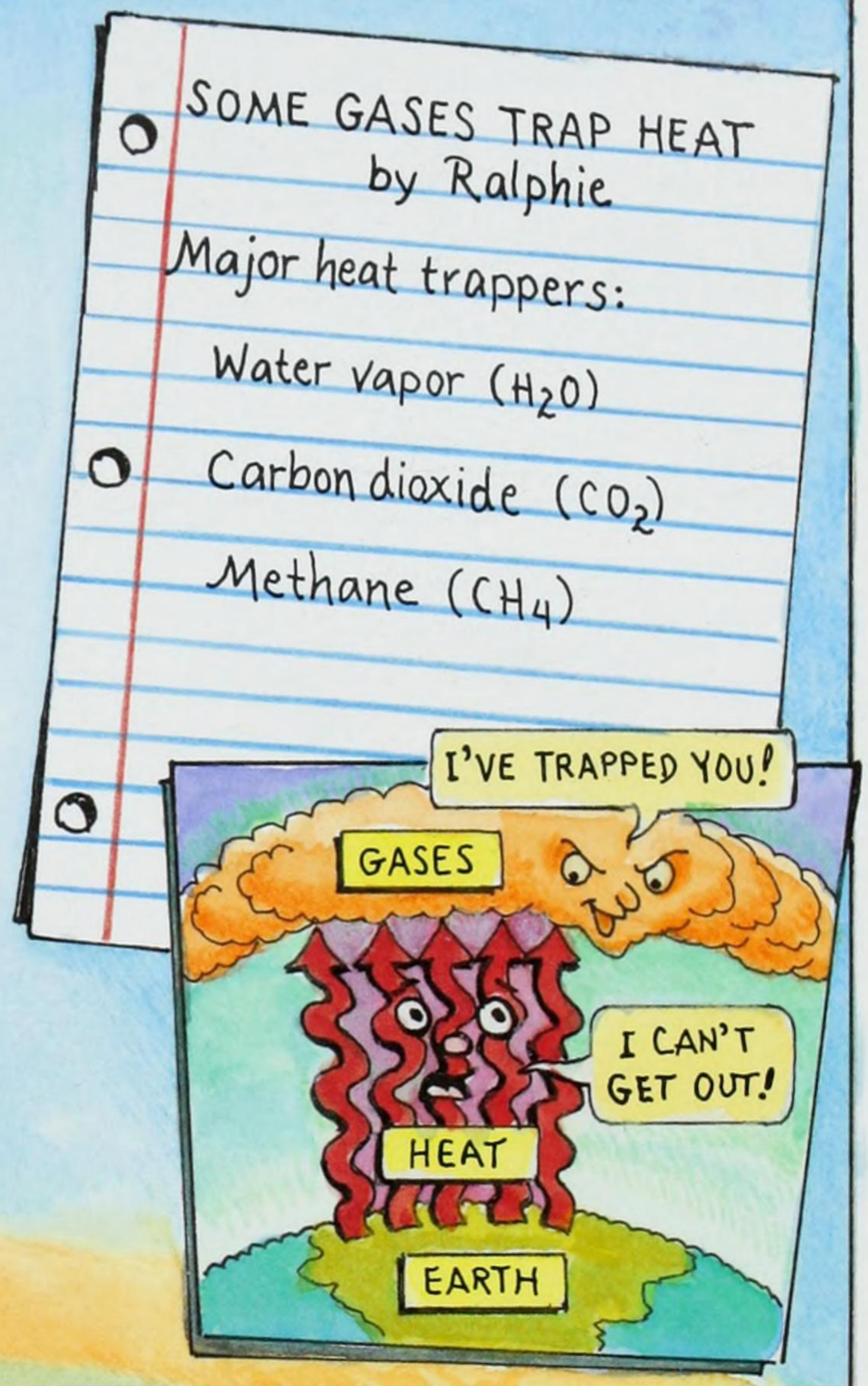
MS. FRIZZLE, AREN'T THERE NATURAL UPS AND DOWNS IN THE CLIMATE?

YES, BUT THEY DO NOT REALLY EXPLAIN WHAT IS HAPPENING ON THE EARTH TODAY.

YAPTOP

DOES ANYTHING EXPLAIN WHAT HAPPENS IN THIS CLASS?

"Most of today's warming is caused by the increasing level of heat-trapping gases in the atmosphere," said the Friz. "Heat-trapping gases are also called greenhouse gases."
She had that funny gleam in her eye.
We could tell something "interesting" was about to happen.



The Friz was going to show us how the atmosphere could make the earth get warmer.
She had flown up so we could look down on the earth.
She gave us special microscope-goggles.
We could see the gas molecules in the air.

TINY STUFF MATTERS
by Wanda

A molecule is a tiny, tiny bit of matter ~ the stuff the universe is made of.

Molecules are made up of even tinier bits called atoms.

MOLECULE

ATOM

EXAMPLES OF MOLECULES:

WATER (H_2O)
two atoms of hydrogen
One atom of oxygen

CARBON DIOXIDE (CO_2)
one atom of carbon
two atoms of oxygen

LOOK, I SEE AN OXYGEN MOLECULE.

OXYGEN'S NOT A HEAT-TRAPPING GAS.

THERE ARE CARBON DIOXIDE AND WATER VAPOR.

UH-OH. THOSE ARE HEAT-TRAPPING GASES.

O = OXYGEN
C = CARBON
H = HYDROGEN
N = NITROGEN

Now our teacher opened the bus door.
"Catch a sunbeam, kids!" she said,
cheerfully pushing us out.
We started sliding toward the earth
on our own sunbeams.

CHILDREN, NOTICE HOW LIGHT RAYS PASS RIGHT THROUGH THE ATMOSPHERE. ISN'T IT FUN?

IN MY SCHOOL, THERE ARE NO TEACHERS LIKE MS. FRIZZLE.

CAN I SWITCH TO YOUR SCHOOL?

HELP!

HELP!

HELP!

Our sunbeams landed gently and warmed the soil.
As the heat started rising from the earth,
we found ourselves going right along with it.
"What an opportunity!" shouted the Friz.
"We're going to learn about the *greenhouse effect*!"

WHAT IS THE "GREENHOUSE EFFECT"?
by Keesha

A greenhouse uses glass to trap heat to keep the plants warm.

The greenhouse effect is when heat-trapping gases act like the glass in a greenhouse and make the earth warmer.

THE HEAT COMES IN, BUT IT DOESN'T GO OUT.

WE WERE LIGHT!

THEN WE CHANGED INTO HEAT!

NOW WE'RE GOING UP INTO THE ATMOSPHERE AGAIN!

CLASS, WE'RE HOT STUFF!

The greenhouse gases trapped some of the heat. That heat headed back to Earth again. It raised the earth's temperature even higher than before.

WE'RE GOING DOWN TO EARTH AGAIN!

WE'RE BEING FRIZZLED AGAIN!

IS THE GREENHOUSE EFFECT BAD?

by Carlos

The greenhouse effect isn't all bad. If there weren't any heat-trapping gases the earth would freeze up.

The natural greenhouse effect keeps the earth at the right temperature for us.

THANK GOODNESS FOR THE NATURAL GREENHOUSE EFFECT!

But when there are too many greenhouse gases, the earth heats up too much. This causes trouble!

I AM ONE HOT DOG!

As we went back to Earth, we looked down. Carbon dioxide—CO_2—was rising into the air. "A lot of extra CO_2 is made when people burn fossil fuels," said the Friz.

WHAT ARE FOSSIL FUELS?
by D.A.

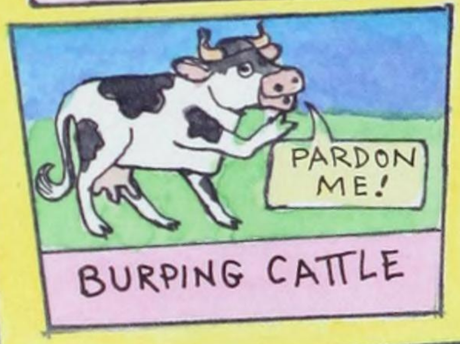
Fossil fuels, such as coal and oil, are made of prehistoric plants that have decayed under the earth.
Some fossil fuels are:
• OIL • COAL • NATURAL GAS

GREENHOUSE GASES ALSO COME FROM:

FOREST FIRES

DECAYING LEAVES

ROTTING GARBAGE



BURPING CATTLE

LOOK AT ALL THE CO_2!

IT'S COMING FROM BUSES, CARS, AND TRUCKS...

...HOUSES AND FACTORIES...

...AND ELECTRIC POWER PLANTS.

Wow! We had finally found out what was causing climate change. It was mostly people—including us. We panicked!

MOST OF THAT CO_2 IS BEING MADE BY THINGS PEOPLE DO!

AND THE CO_2 IS MAKING THE EARTH WARMER AND WARMER!

Q: WHY DO PEOPLE BURN FOSSIL FUELS?

A: TO MAKE ENERGY

by Carlos

Energy is the power to do work.

People need energy to:
- heat houses
- cook food
- run vehicles
- run machines
- make light

"How can we stop global warming?" we wailed.
"One way is to use less energy," the Friz said.
"Another way is to use alternative energy!
That's energy made with less—or no—fossil fuels."

WHY IS GLOBAL WARMING HAPPENING NOW?
by Tim
Humans have been on Earth for about 100,000 years. For most of that time, they didn't make enough CO_2 to change the climate.

Then, about 150 years ago, people invented machines that burned fossil fuel.

Since then, more and more people have been burning more and more fossil fuels.

TODAY THERE IS 30 PERCENT MORE CO_2 IN THE ATMOSPHERE THAN THERE WAS 150 YEARS AGO.

AND MOST OF THE ADDED CO_2 CAME FROM BURNING FOSSIL FUELS.

PROPANE
OIL
GAS-O-LINE
COAL
NATURAL GAS

AND I HAVE TO DRAW MORE AND MORE CO_2 IN THE PICTURES.

Our teacher shooed us back on the bus-plane. Like it or not, we were on our way to see some alternative energy.

IF THE FRIZ IS GOING, WE HAVE TO GO, TOO.

WE DON'T HAVE AN ALTERNATIVE.

ALL ABOARD

TONS OF CO_2

by Keesha

Q: How much CO_2 goes into the atmosphere for each person in the U.S.?

A: Too much! About 44,000 pounds a year. That's the same as eight hefty hippos per person every year!

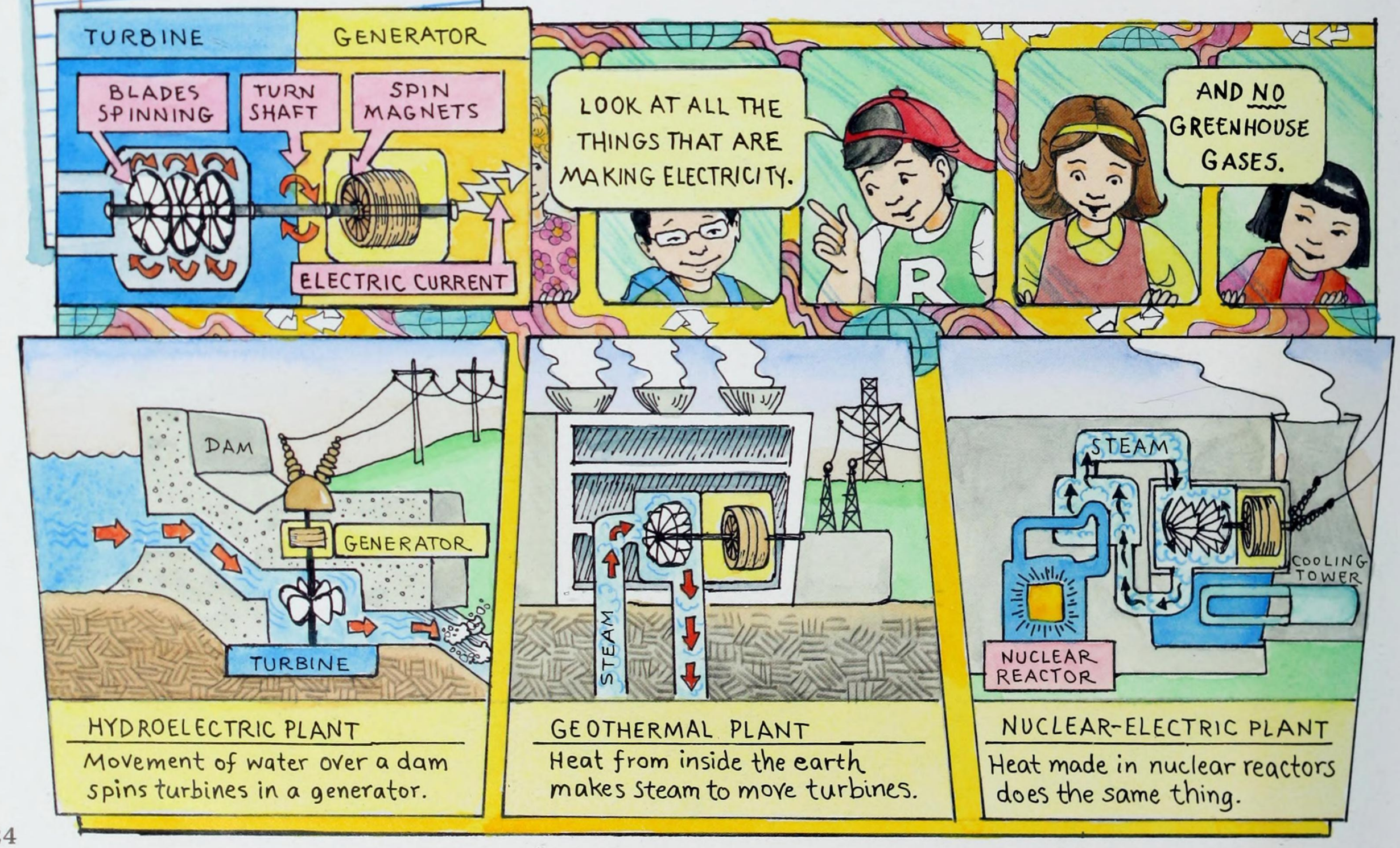
REDUCING CO_2 ~ WHAT'S OUR GOAL?

By the year 2050, Americans should have reduced their hippos a lot. Instead of eight hippos, an American should emit less than one hippo per year.

SPINNING FOR ELECTRICITY
by Arnold

Generators have turbines, or blades, that spin. The spinning movement reacts with magnets to make electric current.

We set out to see generators—
machines that make electricity.
Most generators burn fossil fuel to spin
their turbines and make electricity.
Alternative generators make it without fossil fuels.

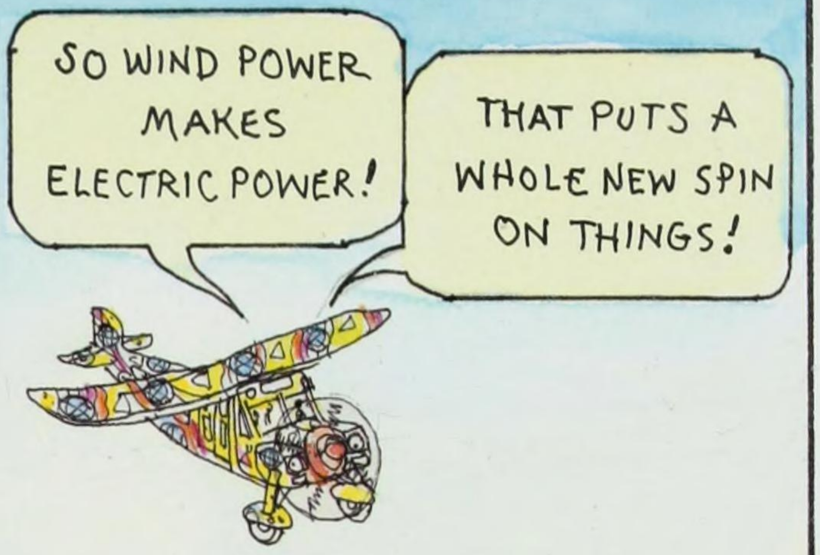


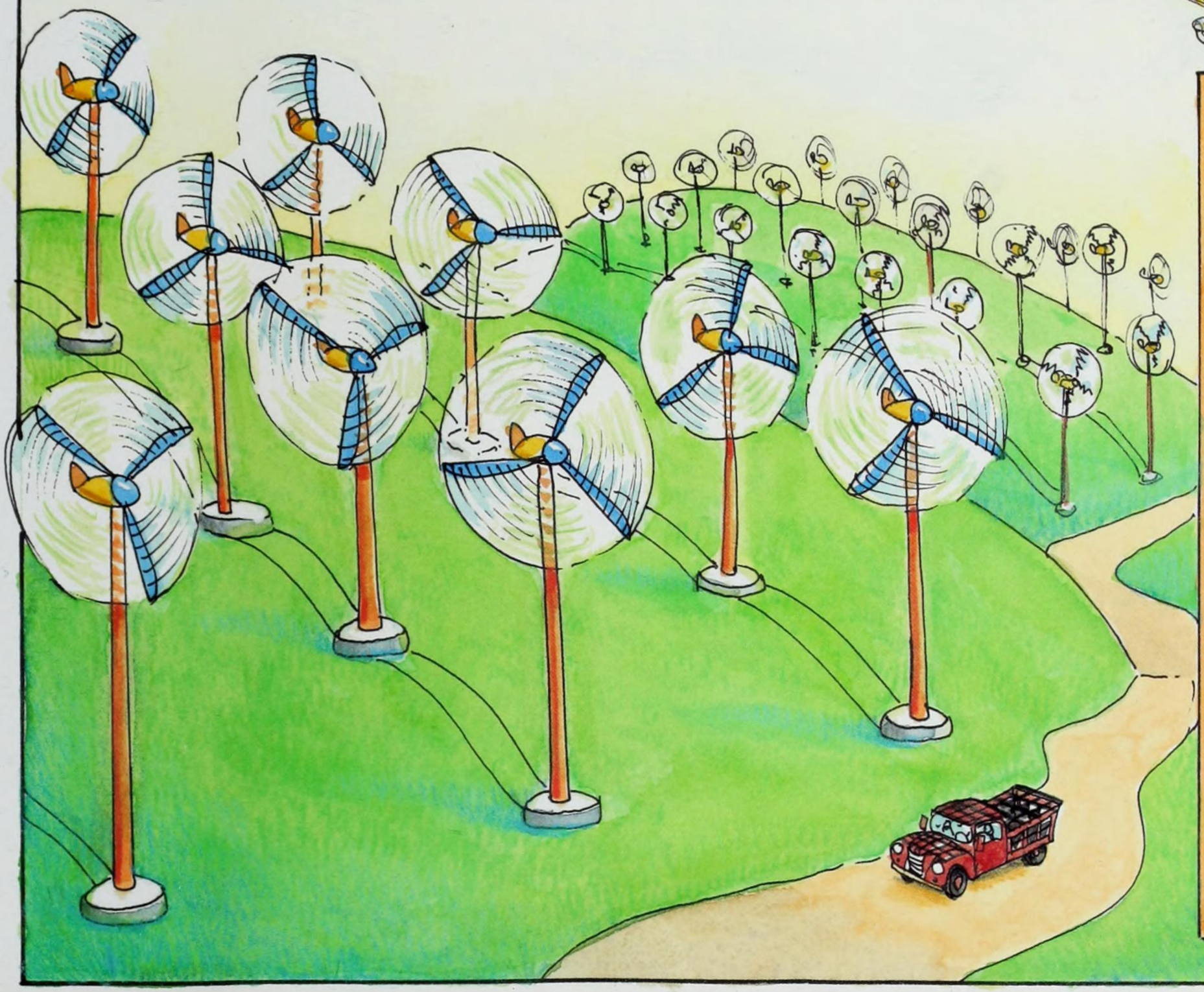
HYDROELECTRIC PLANT
Movement of water over a dam spins turbines in a generator.

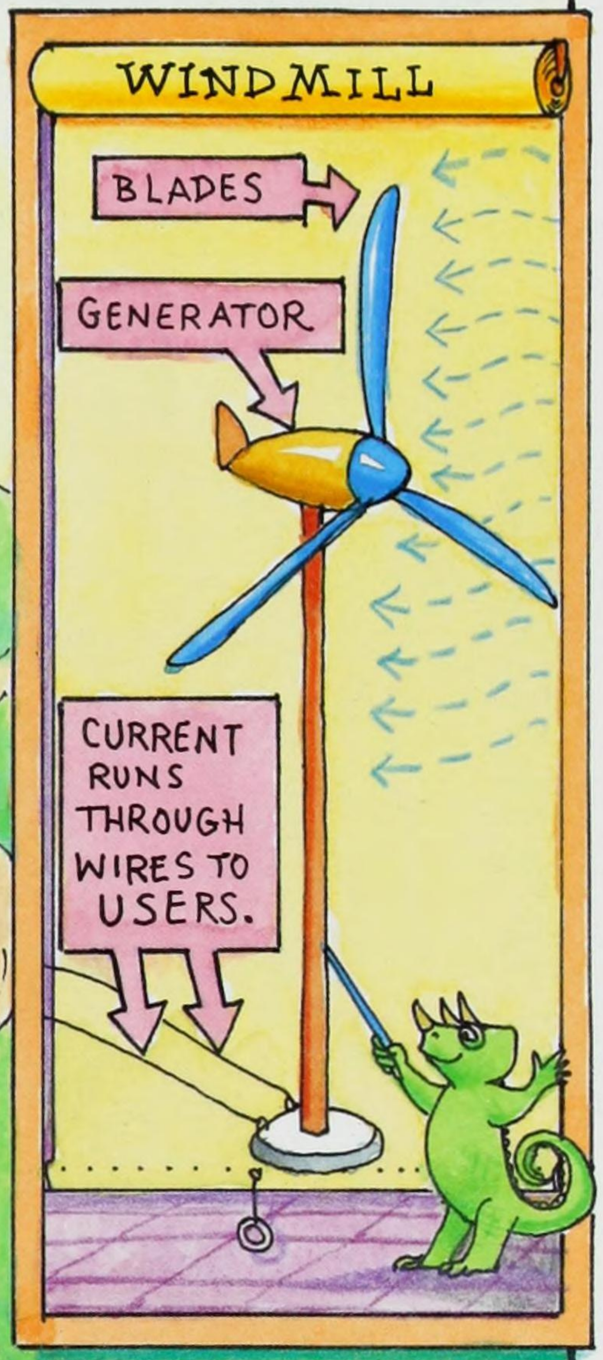
GEOTHERMAL PLANT
Heat from inside the earth makes steam to move turbines.

NUCLEAR-ELECTRIC PLANT
Heat made in nuclear reactors does the same thing.

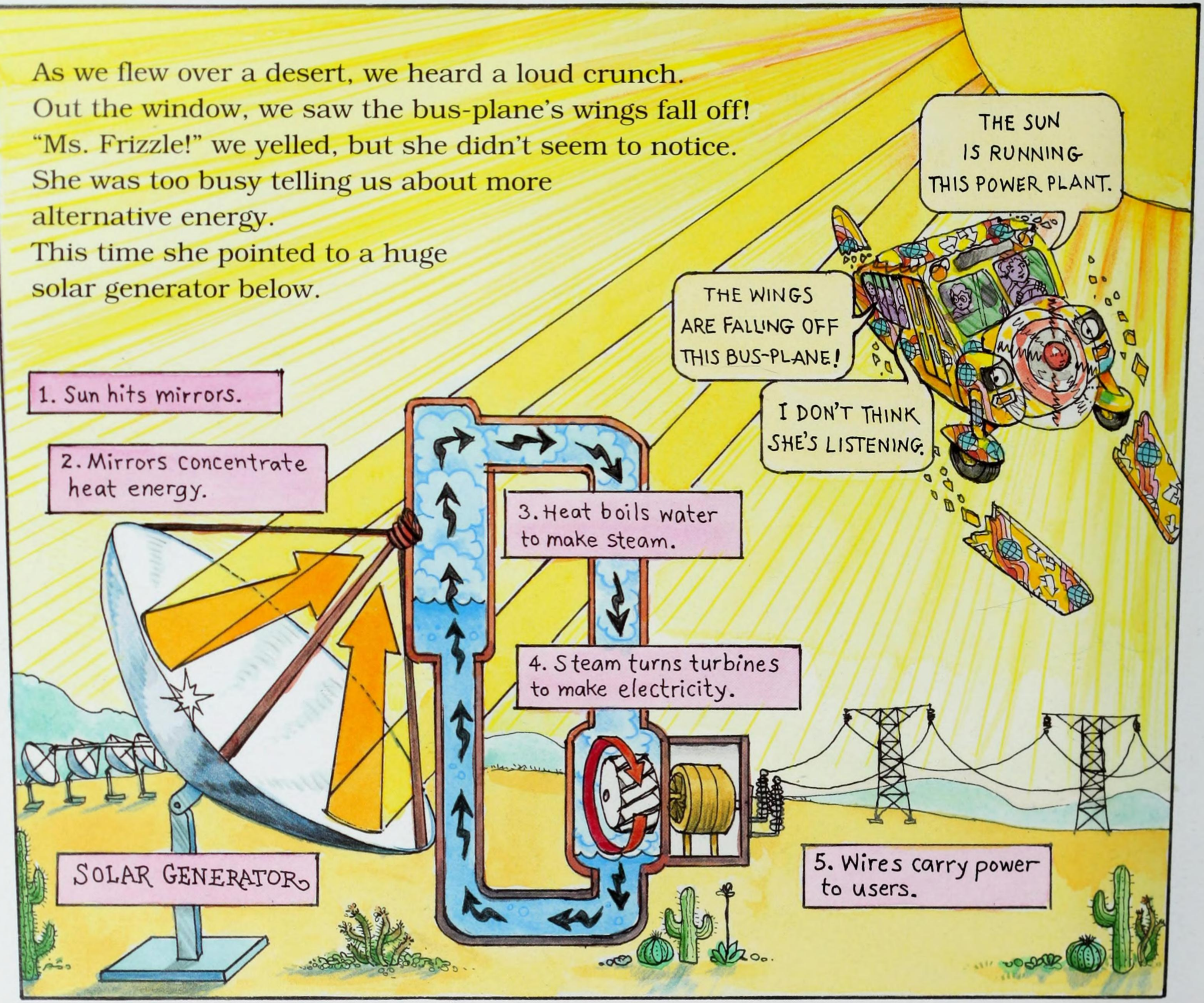
In the countryside, we saw
another alternative: windmills.
The wind turned the blades.
"Anything that moves has energy," the Friz said.
"And energy can be made into electricity."







As we flew over a desert, we heard a loud crunch.
Out the window, we saw the bus-plane's wings fall off!
"Ms. Frizzle!" we yelled, but she didn't seem to notice.
She was too busy telling us about more
alternative energy.
This time she pointed to a huge
solar generator below.


THE SUN IS RUNNING THIS POWER PLANT.
THE WINGS ARE FALLING OFF THIS BUS-PLANE!
I DON'T THINK SHE'S LISTENING.
1. Sun hits mirrors.
2. Mirrors concentrate heat energy.
3. Heat boils water to make steam.
4. Steam turns turbines to make electricity.
5. Wires carry power to users.
SOLAR GENERATOR

The bus made a crash landing.
Oops, we mean a *splash* landing.
We were floating in a solar-heated swimming pool.
Ms. Frizzle kept talking, telling us about solar cells.
They make energy directly from the sun—
with no moving parts.

CHILDREN, DO YOU NOTICE THE MANY DEVICES POWERED BY SOLAR CELLS?

UM... MS. FRIZZLE, DO YOU NOTICE THAT THE BUS IS A GIANT POOL TOY?

ROOF COVERED WITH SOLAR FILM MAKES ALL THE ELECTRICITY A FAMILY NEEDS.

WALKERVILLE TOWN POOL

SOLAR CELLS:
YOU ARE MY SUNSHINE
by Ralphie

Solar cells are made of special materials that make electric current when light shines on them.

The cells are microscopic. They can be put on panels or on a thin film.

Solar bags charge laptops.

HEY! NO SPLASHING!

LENNY THE LIFEGUARD

Solar panels heat pools...

...and run garden lights.

A solar "briefcase" makes energy wherever you need it.

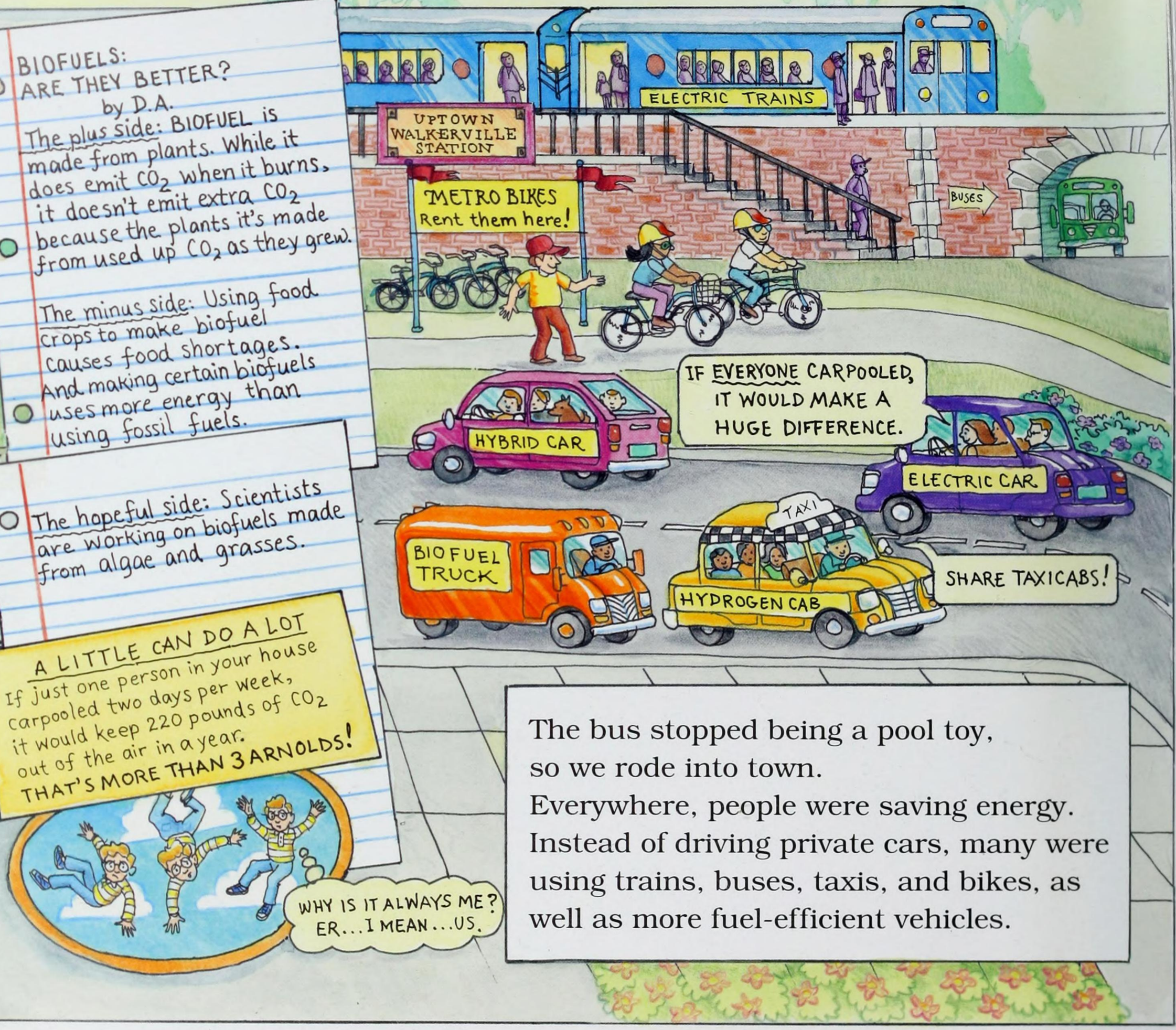
BIOFUELS:
ARE THEY BETTER?
by D.A.

The plus side: BIOFUEL is made from plants. While it does emit CO_2 when it burns, it doesn't emit extra CO_2 because the plants it's made from used up CO_2 as they grew.

The minus side: Using food crops to make biofuel causes food shortages. And making certain biofuels uses more energy than using fossil fuels.

The hopeful side: Scientists are working on biofuels made from algae and grasses.

A LITTLE CAN DO A LOT
If just one person in your house carpooled two days per week, it would keep 220 pounds of CO_2 out of the air in a year.
THAT'S MORE THAN 3 ARNOLDS!



The bus stopped being a pool toy,
so we rode into town.
Everywhere, people were saving energy.
Instead of driving private cars, many were using trains, buses, taxis, and bikes, as well as more fuel-efficient vehicles.

Ms. Frizzle pulled a bright green lever.
At once the bus morphed into a hybrid vehicle that ran on gasoline and a rechargeable battery.
"Can we please go back to school, Ms. Frizzle?" we begged. "We've been on this bus too long!"
For once our teacher listened.

WALKING PATH

HIKE AND BIKE!

BIKE PATH

GO GREEN!

MORE WORDS FROM DOROTHY ANN

A HYBRID VEHICLE uses more than one source of energy.

A FUEL-EFFICIENT vehicle uses **less** fuel to go **more** miles.

KIDS CAN... Take the school bus instead of being driven by a parent.

EVEN AN INEFFICIENT SCHOOL BUS EMITS LESS CO_2 THAN 20 CARS DRIVING KIDS TO SCHOOL.

SCHOOL

KIDS CAN... Ask adults to stop letting vehicles idle.

PLEASE TURN OFF YOUR ENGINE WHILE WAITING.

WORKING TOGETHER!
by Wanda

Richer countries can help poorer countries get alternative energy.

That way, less CO_2 will go into the whole earth's atmosphere, and we'll all be better off.

"We're back!" the Friz exclaimed, pulling into the school parking lot. We put our goggles back on, and we saw greenhouse gases all over the place.

WALKERVILLE ELEMENTARY SCHOOL

THIS IS NOT THE ONLY PLACE THERE'S CO_2.

RIGHT! IT'S ALL OVER THE EARTH!

MS. FRIZZLE, HOW CAN WE CHANGE THINGS ALL OVER THE EARTH?

CLASS, WE CAN START RIGHT HERE, RIGHT NOW!

We had to start saving energy right away.
"Conserve, conserve, conserve!" shouted the Friz.
"Recycle, recycle, recycle!"

I CONSERVE PAPER BY WRITING ON THE BACK.

I CONSERVE PAPER, TOO— BY NOT DOING MY HOMEWORK!

USED PAINT JARS

OLD NEWSPAPERS

MORE WORDS FROM D.A.

Conserve means to avoid waste.

Recycle means to treat waste materials so they can be used again.

RECYCLING SAVES ENERGY
by Tim

Making new cans from recycled cans uses 30% less energy than making them from new aluminum.

KIDS CAN...
Recycle cans and bottles!

A LITTLE CAN DO A LOT

If your town recycled 2,000 pounds of aluminum cans, it would save enough energy to heat the typical home for 10 years.

We started making changes at our school.
There was plenty of room for improvement.
Then we called the mayor of our town.
Then we wrote to the president.

THIS COUNTRY BELONGS TO ALL OF US. LET YOUR VOICE BE HEARD!
USE LESS ENERGY SAVE MORE
MAYOR RIVERA? MAY OUR TOWN GET A WINDMILL, PLEASE?
WHERE TO BUY A WINDMILL
I'M E-MAILING MY SENATOR!
MANY ELECTRONICS ARE "ON" EVEN WHEN THEY ARE "OFF."
HERE'S A TIP~GET A POWER STRIP. THEN SWITCH EVERYTHING ON AND OFF WITH ONE EASY FLIP!
I'M WRITING TO MY CLASS BACK HOME.
ON
OFF

We told everyone, "Let's cut down on greenhouse gases now!"

Don't leave the fridge open too long.
Buy Energy Star appliances.
IT'S NOT COOL TO LEAVE THE FRIDGE OPEN!
ENERGY STAR
Buy things with less packaging.
Buying MORE local produce...
...SAVES ON PACKAGING AND TRANSPORTATION.
Use cloth shopping bags.
Buy LESS bottled water.
Air-dry your laundry.
THE LESS ENERGY YOU USE, THE LESS CO_2 GOES INTO THE AIR.

A LITTLE CAN DO A LOT

If every household in the U.S. switched three lights to compact fluorescent lamps (CFLS), it would reduce as much CO_2 as taking 3.5 million cars off the road.

That's because old incandescent bulbs waste a lot of energy making heat. CFLS use most of their energy making light.

Finally, we had time to put on our play.
It was about everything we had seen on our trip.
We showed what global warming was doing to our planet.
And we told about how people can help.

WARMING ISN'T SO GOOD FOR OUR FORESTS, EITHER.
IT CAUSES DROUGHTS AND WILDFIRES...
... AND IT BRINGS MORE INSECT PESTS.
YUM! WE LOVE GLOBAL WARMING!
HEY, BUGS! STOP EATING OUR FORESTS!
MSBTV
APPLAUSE!

THEY GOT THEIR WHOLE SCHOOL INSPIRED....

THEY GOT OUR WHOLE TOWN INVOLVED....

MSBTV

Can you believe it?
A TV station found out about us,
and we got to be on television!

IT'S SMALL

IT'S BLUE

IT'S ME AND YOU!

MAYOR

PLANNING BOARD

POWER CO.

A LITTLE CAN DO A LOT

If every computer and monitor in the U.S. were turned off at night, we would prevent 7 million tons of CO_2 from going into the atmosphere.

KIDS CAN...

put computers into sleep or hibernate instead of screen-saver mode **AND** switch off and unplug after using for the day.

KIDS CAN...

IN THE SUMMER: Ask an adult to turn the air conditioner one degree warmer.
IN THE WINTER: Ask an adult to turn the thermostat one degree cooler.

As we left school, we asked our teacher,
"Will the earth really be okay, Ms. Frizzle?"
"I hope so," said the Friz.
"Our only chance is to work together—
every person, every city, every country."

LIGHTS OFF

BYE!

Galápagos Islands

1 2 3 4
FINCHES

WE ALL NEED TO TAKE CARE OF OUR EARTH!

WE WILL, MS. FRIZZLE!

THERMAL WINDOW

A/C OFF or HEAT TURNED DOWN

POWER STRIPS SWITCHED OFF

To learn more about climate change, visit your local library or bookstore, and look for kids' sites online.

YOUR TEACHER'S DRESS IS UNUSUAL!

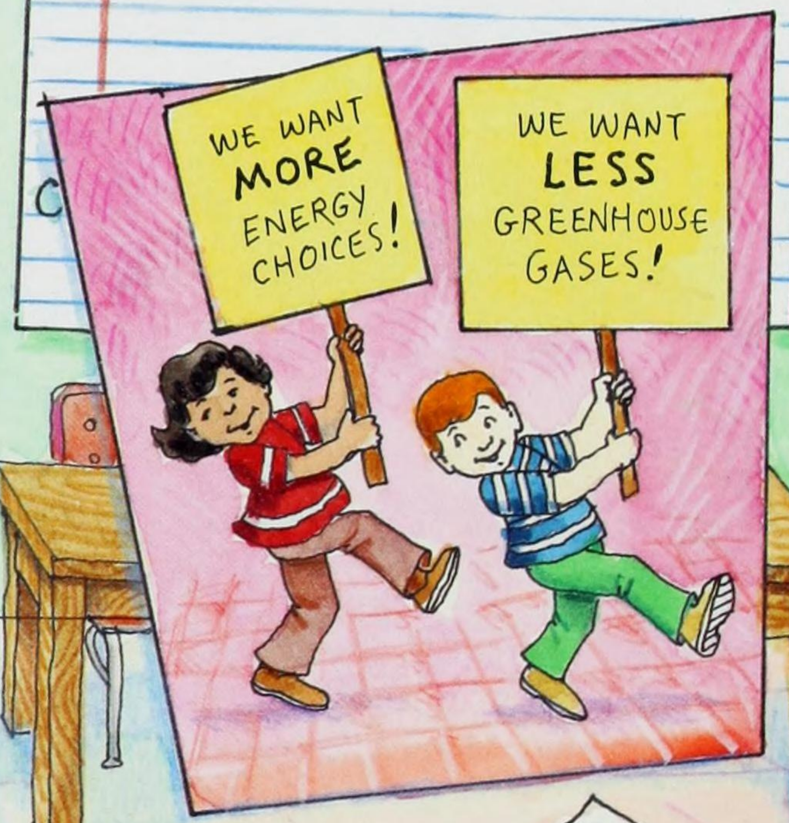
YES, HER TASTE IN CLOTHES IS EVOLVING.

NOW ~ NOT LATER!

by Phoebe

On our trip, we saw many kinds of alternative energy. The good news is: All of them are available now.

The bad news is: Not enough of them are being used yet.



QUESTIONS FOR MS. FRIZZLE'S CLASS

... an online chat

Q. Can a class really go up in the sky and ride sunbeams into the earth?
from IvannaNO@once.now

A. According to our research, only Ms. Frizzle's class can do that.
from Dorothy.Ann@a.loss.to.explain.net

Q. Why are you so worried about global warming? There were warm times in Earth's past, weren't there?
from Onceupon@time.now

A. In past times, Earth's climate has been cool, cold, warm, and hot. But these changes have happened over millions of years. Animals and plants had time to adjust. The warming we see now has happened in only a few hundred years. We can't adapt that fast.
from Ralphie@a.gallop.net

Q. Can a single person really change things?
from Juan@atime4change.net

A. One individual can't make a big difference.
But millions of individuals can!
from Phoebe@longlast/together.net

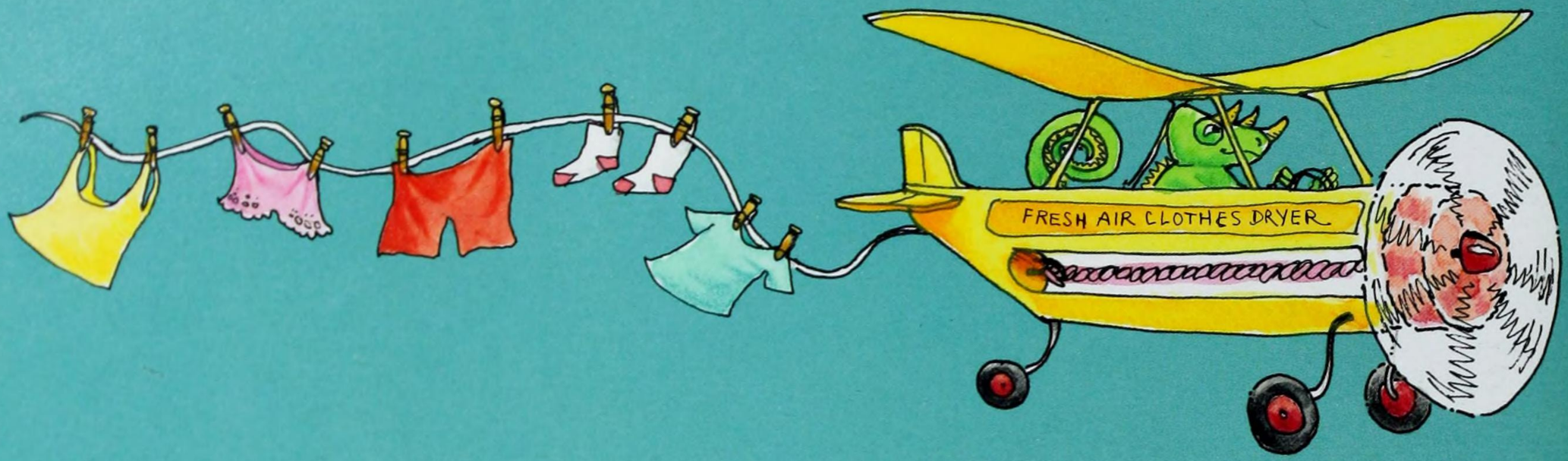
Q. Don't we need bigger help?
from a.giant@least?.net

A. You're right. We need all the governments of the world to cooperate in solving the climate crisis.
from Ms.Frizzle@the.crossroads

Q. Why does Ms. Frizzle always go on such weird class trips?
from kids@risk?safety.net

A. That's what I would like to know.
from Arnold@home.sweet.home

I'M GOING GREEN!
I've always been GREEN!
BIKE!


FRESH AIR CLOTHES DRYER

Joanna Cole and **Bruce Degen** have collaborated for more than twenty years. Named a "can't-miss team" by *Booklist*, Joanna and Bruce have received numerous awards for their work together, the most recent being the National Education Association Award for Outstanding Service to Public Education. They are dedicated to making learning fun, and with the wackiest and wisest teacher in picture books aboard, a good time is guaranteed.

Joanna Cole lives in Virginia, and Bruce Degen lives in Connecticut.

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The Magic School Bus INSIDE THE EARTH

The Magic School Bus INSIDE THE HUMAN BODY

The Magic School Bus LOST IN THE SOLAR SYSTEM

The Magic School Bus ON THE OCEAN FLOOR

The Magic School Bus IN THE TIME OF THE DINOSAURS

The Magic School Bus INSIDE A HURRICANE

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